Spatial/Field-Independence Abilities of Canadian Native Pupils

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This paper points up some cognitive assets of Canadian native pupils which have long been in the lore of anecdotal evidence. In a study testing (among other things) psychological differentiation theory in relation to ecological and cultural variables, a broad battery of cognitive measures was given to 751 subjects described in MacArthur (1973) and in Table 1. (Central Canadian Inuit of Igloolik and Frobisher Bay, Nsenga Zambians of Sandwe and Petauke, West Greenlanders of Augpilagtoq, Kraulshavn, and Upernavik, and Alberta Whites of Strathcona County; age-groups 9 to 12, 13 to 16, 17 to 26, and 27 to 40; balanced by sex, and by subsistence hunting or farming vs. wage-earning, except for Whites). Some of the cognitive measures used are listed in Table 2, and described in MacArthur (1973).

The very general rationale underlying the project views cognitive abilities as if organized in an oblique hierarchy resembling those of Gagné (1962) or Cattell (1963), resulting from interactions of innate predispositions with environmental influences a la Ferguson (1954) or Cole (1971), with local demands strongly influencing what abilities or processes are learned and how they pattern.

In this study, following Witkin (1967)/Dawson (1967)/Berry (1971, 1974) psychological differentiation theory in cross-cultural context, field-independence measures were expected to be positively associated with: some spatial

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abilities, hunting rather than agricultural communities, open and homogeneous vistas rather than closed and variegated vistas, upbringing encouraging initiative and autonomy rather than obedience and conformity at the family level, and limited social and political stratification rather than extensive social and political stratification at the level of the larger community.

Some Results

Ability factor patterns. Oblique higher-order factor analysis (Hendrickson & White, 1966) of cognitive measures for the Canadian Innuit adolescents (Table 2) indicated three main first-order common factors: (1) a verbal-educational factor (here called v:ed) marked by such tests as Arithmetic and English Vocabulary, (2) a spatial/field-independence factor (here called k:m) marked by such tests as WISC Block Design, Witkin Embedded Figures, and New Guinea Performance Scale Form Assembly, (3) a factor of inductive-reasoning-from-nonverbal-stimuli (here called i) marked by such tests as Standard Progressive Matrices.

It should be noted that these three first-order oblique factors were all highly correlated (about .6), and their marker tests all showed high loadings on a third-order factor of general intellectual ability running right through the tests of this cognitive battery. This suggests that the spatial/field-independence and inductive-reasoning tasks are tapping abilities not merely at a concrete level, but at a level of abstract symbolic representation.

As predicted by the rationale behind the study different factor

patterns appeared for different ethnic groups and age-levels. But since the above three factors are recognizable for other samples, either with some splitting or in some combination, they may be used to structure discussion of cognitive abilities here.

Differential abilities relative to Whites. Figure 1 summarizes several findings of the study. T-score norms based on the Canadian Central Eskimo adolescents were prepared for each of the ability measures, so that in Figure 1 this sample has a mean of 50 on each of the three groups of ability measures (k:m, i, v:ed). Mean T-scores based on norms of this reference sample were obtained for each of the other samples on each test. Medians of these mean T-scores, taken over each of the three groups of ability measures, are shown in Figure 1 for the Greenland, Nsenga, and Alberta adolescents.

Though all four adolescent samples were of the same stated age, parental occupations for the Whites were much higher in the Canadian sense, the Whites had two years more of schooling, and for the Nsenga the teachers were less well prepared in the Euro-American sense. Thus on these tests evolved mainly from Euro-American culture, it is of no theoretical interest that in Figure 1 the graph for the Nsenga (x-ed line) parallels that for the Whites (dotted line) but at a much lower level. (This simply repeats ad nauseam that on our tests, Africans of lower parental occupation and less schooling score lower than Whites). But as indicated by the oval at the left, on the spatial/field-independence tasks the Central Canadian and Greenland Eskimos with their hunting background, ecology demanding minute visual discrimination, and upbringing encouraging initiative and resourcefulness, perform at about

the same level as that of the Whites. On these same tasks the Nsenga with subsistence farming background, closed vistas, and upbringing encouraging toward conformity to authority, perform much lower. Hypotheses in this connection from psychological differentiation theory, then, are clearly confirmed.

On the verbal-educational tasks (to the right of the Figure) the three indigenous samples perform similarly, all below the Whites. The inductive-reasoning tasks fall between these two extremes. For children of stated age 9 to 12 years the graph remarkably resembles that for the adolescents. (On the k:m tasks the Central Eskimo children scored at exactly the same level as their White age-mates).

Differential abilities relative to age. Within each indigenous group an inverted U-shaped relation was expected between age and level of ability on tests common to the four age-groups. However, as Table 3 shows, for the Central and Greenland Eskimos on the k:m tasks there were almost no significant differences in means between the adolescents with six years of schooling and the middle-aged adults with little schooling.

Differential abilities relative to transition. Table 4, using four transition markers in illustration, shows that for the Eskimo adolescents there was a clear trend for the spatial/field-independence group of abilities to be related almost not at all to degree of transition toward technological society, for the inductive-reasoning abilities to be somewhat related thereto, and for the verbal-educational to be much more related to degree of transition. For the Nsenga there was considerably more relation of spatial abilities to degree of transition (MacArthur, 1974 a).

Abilities relative to sex. One of the striking findings of this study was almost no sex differences in any of the ability tests for any of the age-groups in any of the ethnic samples (MacArthur, 1974 b). This finding strongly suggests that on this broad battery of cognitive tasks for these samples such sex differences as do occur are not likely of biological origin, but are related to circumstances in the upbringing of a particular age-group in a particular setting at a particular time.

Indian-Metis and Inuit of Western Arctic and Alberta. In many instances studies of North American indigenes have tended to treat our native peoples as if they were homogenous, with little regard for the great ecological and cultural diversity characterizing the various groups. However, previously reported studies by MacArthur (1962, 1965, 1968a, 1968b, 1969), by Vernon (1969), and by Bowd (1973), indicate that, with relatively minor differences in patterning of abilities and in performances on particular tests, the results outlined above can be generalized with some confidence to Mackenzie Eskimos of the Western Arctic and to Indian-Metis of the Mackenzie District and of Alberta.

Some Educational Implications

Cognitive strengths of Canadian native pupils. Cognitive strengths of our Inuit peoples (and Indian-Metis of Mackenzie District and Alberta) relative to their White age-mates, lie clearly in the spatial/field-independence cluster of abilities. Within Eskimo samples this ability cluster is little related to degree of transition toward technological society, and middle-aged adults with little schooling have developed these abilities as

well as have young adolescents who are in school. Anecdotal evidence has long praised the navigational and mechanical skills of the Eskimos. Across ethnic-group, across age-group, and within age-group data confirm in terms of well-known standard psychological tests, and even for child samples, the relatively highly developed spatial and field-independence abilities which the Eskimo has developed in his traditional life. It should be noted that in Euro-American society such tests as Block Design, Form Assembly and Embedded Figures are widely established indicators of technological aptitude.

A second level of cognitive strengths of these Eskimo samples is represented by the tasks involving inductive reasoning from nonverbal stimuli. This factor's emergence and strength over v:ed abilities agrees closely with previous results for two samples of Mackenzie Eskimo and two Indian-Metis samples living well over 1000 miles from the Central Eskimo. (MacArthur, 1968a, 1969).

It is in the verbal-educational group of abilities that our native pupils demonstrated their greatest weakness relative to their White age-mates.

Implications for education. In terms of practical implications for Eskimo and Indian-Metis pupils in formal educational settings their relative strengths in k:m and i abilities suggest:

(a) clear distinction between subjects of content of instruction, and methods or media of instruction.

(b) content of instruction is a value matter of course, in this writer's view best decided by the native peoples directly concerned, but the evidence suggests development of both spatial/field-independence and

verbal abilities as aims for subjects of instruction.

(c) The evidence suggests much more emphasis than is usually present in schools and other educational institutions on the use of nonverbal stimuli and k:m abilities as media of instruction. Cross-cultural psychologists have gone some distance in developing principles and practices for helping people of other cultures learn how to do essentially Euro-American tests. Now no-one cares, of course, whether other people can do our tests, but these same approaches can be used in helping people from other cultures to learn----whatever they may wish to learn.

From a psychologist's view-point these main principles may be summarized thus: (1) Use of instrinsically interesting materials, perhaps starting with essentially Western, but progressively seeking exemplars from local practices of the constructs under instruction or test, (2) Making stimulus problems and responses little dependent on verbal or pictorial communication, with emphasis on communication by manipulating materials and by gesture, (3) Explicit instruction via small steps with immediate feedback to testor and testee, and with immediate testee reinforcement, (4) Reduction of extransous stimuli, so that the problem stands out as clear "figure" with as little as possible "background noise" such as printed instructions, or other items on a page or table-top, (5) Assistance in pacing, (6) Emphasis on clinical more than technical standardization of test administration procedures, including warmth and personal attention, (7) Respect for testee as a person, not just a subject.

Such principles can be adapted for teaching at the level of centralized production of so-called audio-visual educational materials and directions

for their use, but perhaps more important is implementation of the attitudes they imply in day-to-day teaching by the classroom teacher in using varied approaches in the same lesson or lesson sequence. As a simple example, Kleinfeld (1973) uses Venn diagrams to supplement the traditional verbal approach to teaching superordinate and subordinate class relationships.

Current approaches to curriculum development in the Northwest Territories. A commendable outline of principles for curriculum development for native pupils of the Northwest Territories is given in the 1974 Yearbook of the Canadian Society for the Study of Education (Robinson, 1974). I here refer to only one aspect, his principle concerning media of instruction.

> The tie that binds the curriculum is communication, broadly defined. Conventionally, communication is thought of in terms of the language arts: listening, speaking, reading, and writing. This interpretation is too narrow in that it excludes communication via art, music, drama, mathematics, science experimentation, physical education and recreation; and indeed any activity through which the individual conveys meaning without the necessity of resorting to verbalization....a variety of avenues of communication should be explored and utilized....Pantomine, cuisenaire rods, jigsaw puzzles, creative dance--all are ways and means of communication....Moreover, there is little reason, save tradition itself, for the continuing emphasis that is placed on print as the one effective communication tool....film...tapes, records, and transparencies are often not used sufficiently. Reitertated in stronger terms, a successfully enunciated curriculum will be amenable to mediation via the widest range of possible communication modes. (p. 38).

The article illustrates this principle with description of a range of multicultural learning materials that may be and are being prepared, incorporating the involvement of Inuit and Indian peoples themselves in the collection, translation and illustration of materials which meet their interests and are based on their customs and traditions. Perhaps more important than

these materials are the so-called "yellow pages" of the handbook for elementary curriculum development in the Northwest Territories, listing many many activities for use in day-to-day teaching, which can help the native pupil use and build upon the cognitive strengths he has brought to the classroom.

Summary

In a study testing (among other things) psychological differentiation theory in relation to ecological and cultural variables, a broad battery of twenty-nine cognitive measures was given to 751 cases ages 9 to 40 years in four ethnic groups (Canadian Central Inuit, West Greenlanders, Zambian Nsenga, and Alberta Whites). While as predicted, factor patterns varied considerably from age to age and from group to group, three main factors were recognizable, either with some splitting or in some combination: a verbal-educational factor, a spatial/field-independence factor, and a factor of inductive-reasoning-from-nonverbal stimuli.

Cognitive strengths of the Eskimo samples relative to their White age-mates lay clearly in the spatial/field-independence cluster of abilities. Within Eskimo samples this ability cluster was little related to degree of transition, and middle-aged adults with little schooling have developed these abilities as well as have young adolescents who are in school. Implications for Eskimo pupils in formal educational settings suggest much more emphasis than is usual at present on: (a) nonverbal and spatial abilities as media of instruction, and (b) development of these abilities as aims for content of instruction.

This paper helps provide research-based underpinning for the principles and practices in curriculum development for native pupils outlined

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H A N D O U T

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~~social environments? and (b) What particular abilities are related to what particular environmental influences?~~ Table 1 summarizes some descriptive data for the sixteen samples.

TABLE 1

SOME DESCRIPTIVE DATA FOR 16 SAMPLES - N's, MEANS, AND TEST BATTERIES*

	Sample No.	Age 9 to 12	Sample No.	Age 13 to 16	Sample No.	Age 17 to 26	Sample No.	Age 27 to 40	Total	Year Field Work
Number of Cases										
Central Eskimos	11	61	12	62	13	29	14	25	177	1969
Nsenga Africans	21	65	22	65	23	31	24	31	192	1970
Greenland Eskimos	31	65	32	64	33	23	34	24	176	1971
Alberta Whites	41	70	42	64	43	36	44	36	206	1972
Total		261		255		119		116	751	
Stated Age	11	10-5	12	14-4	13	21-0	14	33-7		
	21	10-4	22	14-4	23	20-0	24	32-11		
	31	10-9	32	14-0	33	20-11	34	35-3		
	41	10-4	42	14-4	43		44			
Years in School	11	3.3	12	6.0	13	5.3	14	0.6		
	21	3.1	22	6.4	23	6.6	24	2.9		
	31	3.7	32	6.8	33	7.0	34	7.0		
	41	4.4	42	8.5	43		44			
Grade	11	2.2	12	4.6						
	21	3.6	22	6.4						
	31	3.0	32	6.0						
	41	4.2	42	8.5						
Occupation (Blishen 1967)	11	28.4	12	29.6	13	31.9	14	30.4		
	21	37.4	22	33.7	23	38.0	24	30.9		
	31	31.5	32	31.1	33	28.0	34	27.5		
	41	39.3	42	43.4	43		44			
Test Batteries	I, II, III		I, II		I		I			

* Within each sample balance by sex, and (except for Whites) by less/more transitional orientation. Data for samples 43, 44 not yet available.

Cognitive measures used were in three batteries: Battery I administered to all subjects included eleven measures selected from those recommended in I.B.P. Handbook 10 (Biesheuvel, 1969, which see for additional description of them); Battery II for pupils with at least two years of schooling included another thirteen tests, mostly adapted from those used by Vernon (1969); Battery III for younger

TABLE 2

PART OF FACTOR PATTERNS OF ABILITIES FOR ADOLESCENT CENTRAL ESKIMO SAMPLE 12 AND NSENGA AFRICANS SAMPLE 22. (OBLIQUE PROMAX-COEFFICIENTS BELOW .35 OMITTED)

Tests	Primary Factor Pattern First Order: Eskimo 3 of 8 Factors 1	2	3	Nsenga 2 of 7 Factors 1	2	Third Order Esk. 1	Nsen. 1	Unrotated First Principal Esk. 1	Nsen 1
1. Block Design WISC		.88			.85	.75	.56	.72	.61
2. Emb. Fig. Witkin		.95			.79	.66	.64	.62	.72
3. Emb. Fig. AID 1		.70			.91	.59	.41	.63	.49
4. 2		.81			.76	.62	.55	.73	.65
5. Emb. Fig. Vernon		.38	.57		.70	.64	.73	.72	.72
6. Form Assembly NGPS		.71		.44		.63	.61	.45	.61
7. Passalong NGPS		.68				.69	.39	.56	.35
8. Draw Man Witkin		.36			.46	.39	.45		.64
9. Progr. Matrices A			.86		.91	.56	.61	.43	.51
10. B			.82	.40		.61	.77	.55	.66
11. C			.87	.92		.69	.65	.70	.73
12. D			.89	.90		.66	.73	.66	.80
13. E			.43	.94		.50	.64	.63	.73
14. SCRIT Scale 2			.64	.43		.72	.62	.77	.65
15. MAC 2			.61	.47		.69	.68	.65	.76
16. Lorge-Th. NV3 1		.60				.58	.59	.67	.57
17. 2		.49	.40	.62		.71	.62	.79	.73
18. 3	.48			.55		.65	.76	.82	.77
19. Memory Designs Benton				—	—	.47	—	.55	—
20. Shipley Abstraction	.52			.82		.79	.76	.91	.91
21. English Vocab. Oral	.93			.64		.37	.65	.61	.79
22. Arithmetic Computation	.86			.86		.67	.72	.85	.88
23. Problems	.70			.88		.72	.71	.83	.87
24. Grade in School	1.02			1.03		.60	.63	.80	.84
25. Eng. Rdg & Usage	.99			1.00		.66	.68	.84	.90
26. Eng. Vocab. Written	1.00			.87		.70	.61	.81	.83
27. Otis Beta	.94			.67		.69	.49	.85	.68
28. Spelling	.86			.93		.73	.62	.84	.86
29. Information Lrng.	.79			.95		.65	.66	.74	.89
30. Word Learning				.50		.63	.40	.58	.66
31. Illusions M-Lyer									
32. Sander									
33. T						−.38			
34. L						−.43			
35. Visual Acuity									
Prop. Total Variance	.25	.15	.14	.36	.14	.37	.34	.43	.45
Factor Correlations	1	2	3	1	2				

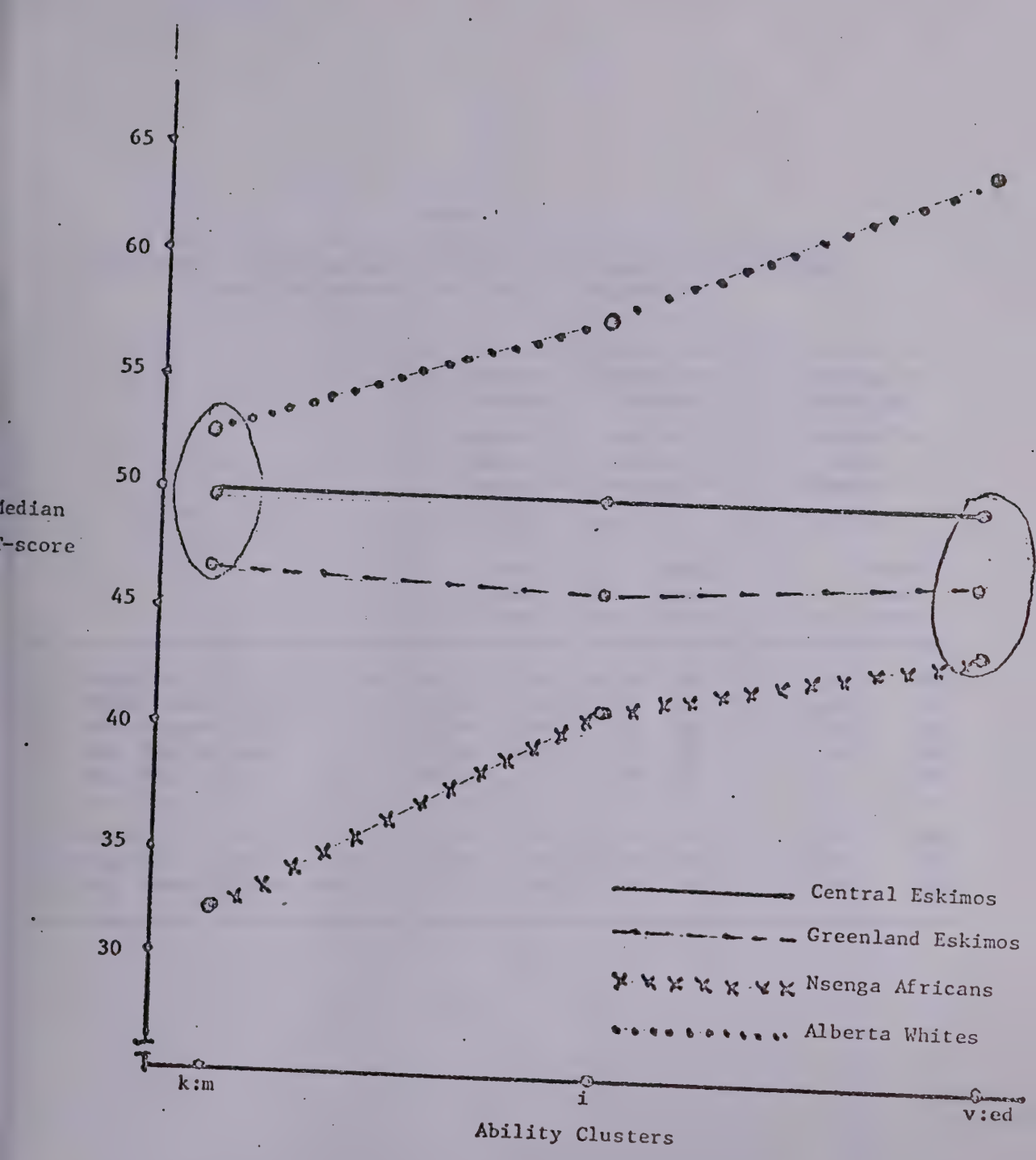

Fig. 1. Medians, over clusters of ability measures, of mean T-scores for adolescent ethnic groups.
(Based on Central Eskimo adolescents as reference group.)

Table 3

Significance of Differences of Means on Common Ability Tests, Young Adolescents vs. Middle-Aged Adults

Test	Central Eskimos Sample 12 minus Sample 14 d.f.85		Greenland Eskimos Sample 32 minus Sample 34 d.f.86		Nsenga Africans Sample 22 minus Sample 24 d.f.94	
	t	Prob. less than	t	Prob. less than	t	Prob. less than
1. Passalong NGPS	-1.27	.30	-2.35	.05	.14	.90
2. Block Design WISC	1.16	.30	- .57	.60	1.48	.20
3. Form Assembly NGPS	1.79	.10	.18	.90	.39	.70
4. Emb. Fig. Witkin	2.16	.05	1.21	.30	4.20	.001
5. Emb. Fig. AID	8.23	.001	2.70	.01	5.75	.001
6. MAC 2	3.21	.01	2.55	.02	8.18	.001
7. Progress. Matrices Total	5.70	.001	5.83	.001	8.13	.001
8. Eng. (Dan.) Vocab. Oral	5.77	.001	3.89	.001	5.69	.001

Table 4

orrelations of Ability Tests with Some Transition Markers for Adolescent Eskimos (Age 13 to 16)

	Wages vs. Land (Head)		Appliance Ownership (Home)		Eng.(Dan.) Use with Friends		Time in School (Self)	
ample	12	32	12	32	12	32	12	32
. Draw Man Witkin	01	11	-15	12	10	16	-01	12
. Emb. Fig. AID 1	03	00	17	01	18	07	14	24
2	06	13	19	19	13	28*	32*	32*
. Block Design WISC	-06	23	00	38*	12	32*	14	50*
. Memory Designs Benton	05	16	20	22	13	31*	26*	28*
. Emb. Fig. Vernon	-03	18	07	21	14	21	20	30*
. Form Assembly NGPS	-14	10	-01	22	09	-21	06	33*
. Passalong NGPS	-05	-02	-10	03	11	25*	07	23
. Emb. Fig. Witkin	11	11	-09	12	15	33*	16	38*
. Progress. Matrices A	-04	26*	-05	24*	13	27*	09	28*
. B	34*	32*	16	23	27*	36*	29*	35*
. C	21	43*	13	45*	28*	39*	20	48*
. D	30*	49*	23	46*	25*	39*	31*	54*
. E	14	30*	29*	51*	31*	43*	23	31*
. SCRIT Scale 2	12	31*	24*	36*	12	29*	26*	40*
. MAC 2	24*	19	03	27*	21	33*	14	29*
. Lorge-Th. NV3 1	13	25*	13	40*	17	22	16	26*
. 2	15	30*	17	41*	22	33*	38*	36*
. 3	17	31*	29*	45*	30*	46*	57*	58*
. Word Learning	15	--	-05	--	15	--	11	--
. Spelling	28*	--	44*	--	42*	--	57*	--
. Shipley Abstraction	21	--	31*	--	33*	--	49*	--
. Arithmetic Computation	33*	25*	44*	28*	35*	46*	60*	46*
. Eng. Rdg. & Usage	23	--	42*	--	42*	--	68*	--
. Information Learning	21	--	32*	--	32*	--	43*	--
. Otis Beta	10	--	34*	--	57*	--	38*	--
. Grade in School	27*	42*	54*	42*	46*	39*	72*	78*
. Eng. (Dan.) Vocab. Oral	13	23	35*	40*	43*	66*	47*	49*
. Eng. Vocab. Written	13	--	33*	--	43*	--	52*	--
. Arithmetic Problems	05	25*	32*	38*	35*	58*	53*	62*
. GNVTB 4 Spatial	--	23	--	41*	--	42*	--	35*
. 2 Similarities	--	28*	--	34*	--	26*	--	30*
. 3 Differences	--	30*	--	40*	--	31*	--	41*
. 5 Matrices	--	30*	--	44*	--	44*	--	42*
. 6 Series	--	28*	--	42*	--	36*	--	41*
. Illusions T	-04	04	07	10	12	03	-06	-02
. L	15	07	16	-07	-24*	13	01	03
. Sander	-11	16	-22	08	-24*	-06	-08	-03
. M-Lyer	00	03	13	05	02	02	17	14

ignificant at .05 level. Decimal points omitted.

Table 4

Correlations of Ability Tests with Some Training Criteria for Adolescent Children (Age 12 to 17)

Test	Stage 1 (Grade)		Stage 2 (Grade)		Stage 3 (Grade)		Stage 4 (Grade)	
	12	32	12	32	12	32	12	32
Form Han Writin	02	11	-15	12	19	16	-01	12
Comb. Fig. Asso	06	00	27	01	16	07	19	24
?	08	13	18	19	13	28*	34*	32*
Block Design Mis	-06	25	00	18*	12	33*	14	36*
Memory Design Re	05	10	20	22	13	34*	18*	28*
Comb. Fig. Visu	-02	12	07	21	14	21	00	30*
Form Assembly Mo	-14	10	-01	22	09	-01	06	23*
Picture Along Mo	-05	-02	-10	03	11	28*	07	23
Comb. Fig. Visu	27	11	-09	12	15	23*	19	39*
Progress. Matrices A	-06	20*	-01	24*	13	37*	01	28*
B	24*	23*	15	23	27*	36*	28*	36*
C	21	11*	13	42*	23*	39*	20	46*
D	20*	40*	23	46*	23*	39*	31*	44*
E	16	30*	23*	31*	31*	42*	22	37*
SCAIT Scale 2	12	21*	25*	36*	12	32*	26A	40*
DAC 2	24*	19	03	27*	21	33*	19	29*
Comp-Th. RA1 2	13	23*	13	40*	17	32	10	26*
3	15	20*	17	41*	23	33*	34A	32*
5	17	31*	23*	42*	20*	40*	32*	38*
Word Learning	13	—	-05	—	13	—	11	—
Spelling	20A	—	40*	—	15*	—	25*	—
Sylgby Abstraction	21	—	31*	—	23*	—	41A	—
Arithmetic Computation	21*	27*	46*	25*	23*	46*	00*	46*
Eng. Neg. & Usage	25	—	02A	—	42A	—	06*	—
Information Learning	21	—	32*	—	22*	—	07*	—
Opis Meta	10	—	24*	—	17*	—	28*	—
Grade in School	21A	40*	32*	41*	18*	32*	21*	28*
Eng. (Dan.) Vocab. Oral	11	23	32*	40*	12*	09*	11*	19*
Eng. Vocab. Writing	13	—	23*	—	13A	—	15*	—
Arithmetic Problems	05	23*	22*	38*	12*	18*	31A	42*
CAVIK A Spatial	—	23	—	01*	—	42*	—	32*
2 Similarities	—	28*	—	34*	—	32*	—	32*
3 Differences	—	30*	—	40*	—	31*	—	31*
5 Matrices	—	30*	—	44*	—	44*	—	42*
6 Series	—	28*	—	42*	—	32*	—	41*
Illusions T	04	07	10	-12	03	-06	-02	
L	15	07	10	-02	22*	13	01	07
I Sander	-11	10	-22	06	22*	+06	-08	-03
M-Ivre	07	03	13	05	02	02	12	14

Significant at .05 level. Decimal points omitted.

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